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**Reiter et al.**

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(54) **CHAINRING**

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**F16H 7/06** (2006.01)  
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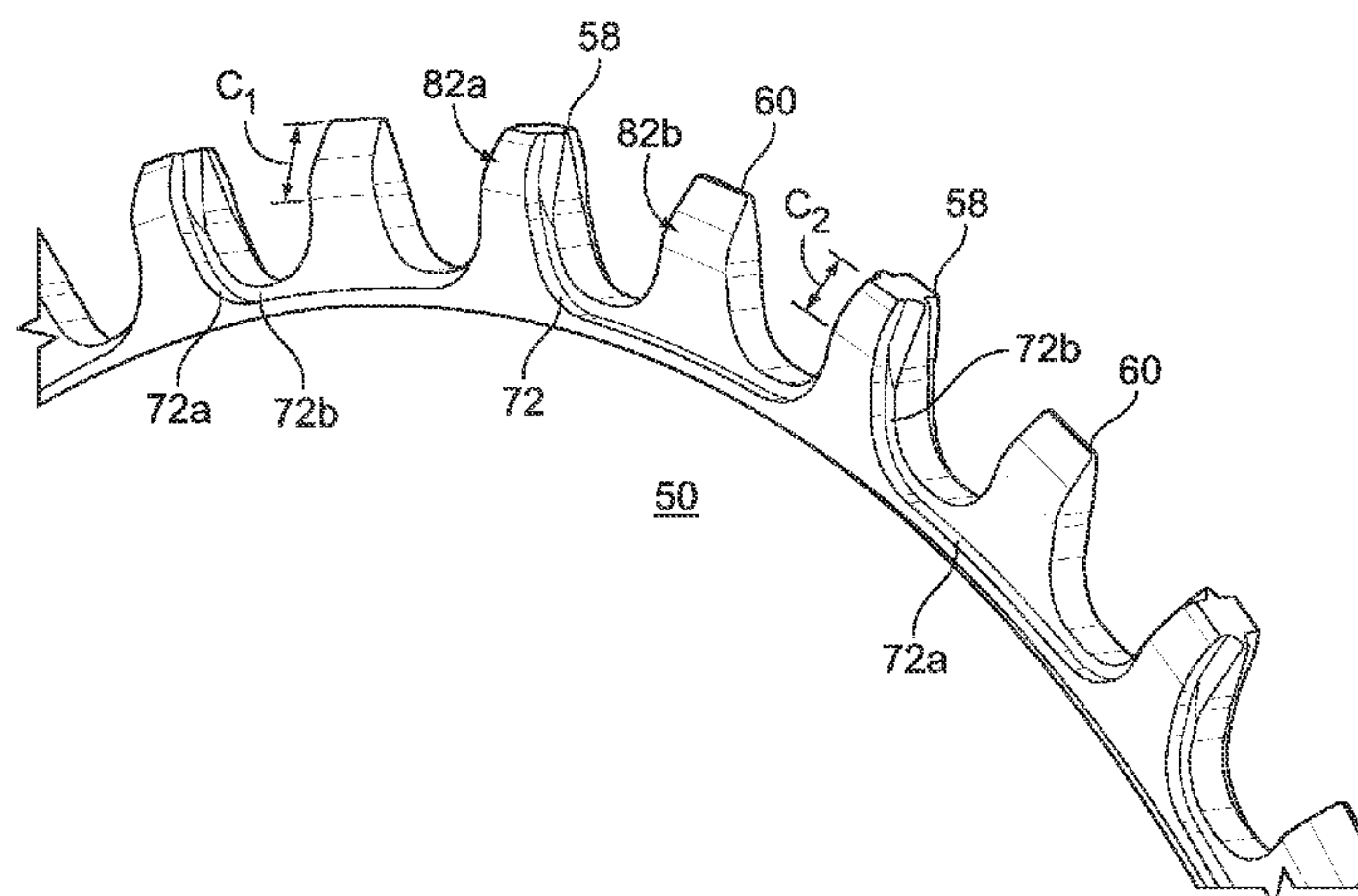
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*Primary Examiner* — Henry Liu  
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(57) **ABSTRACT**

A bicycle chainring includes a plurality of teeth extending from a periphery of the chainring wherein roots of the plurality of teeth are disposed adjacent the periphery of the chainring. The plurality of teeth including a first group of teeth and a second group of teeth, each of the first group of teeth wider than each of the second group of teeth. At least some of the second group of teeth are arranged alternately and adjacently between the first group of teeth, each of the plurality of teeth includes an outboard side and an inboard side opposite the outboard side and one of the inboard and outboard sides of each of the second group of teeth includes a link-receiving recess formed in the chainring.

**14 Claims, 9 Drawing Sheets**



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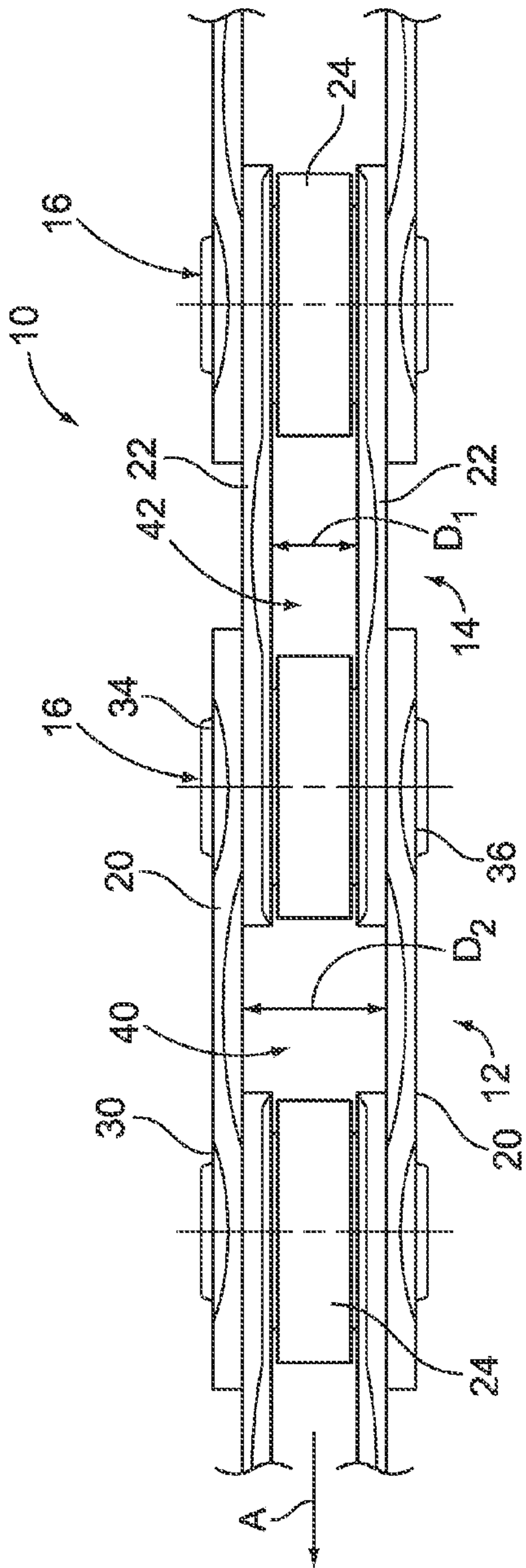


FIG. 1

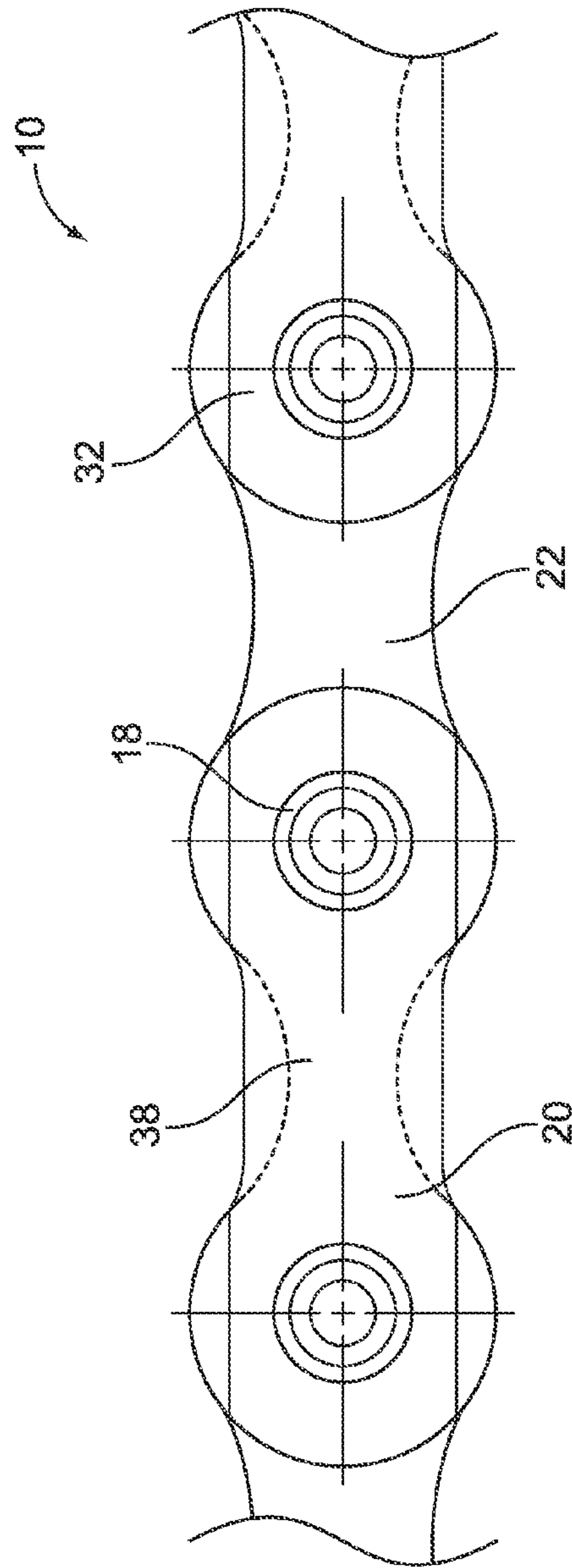


FIG. 2



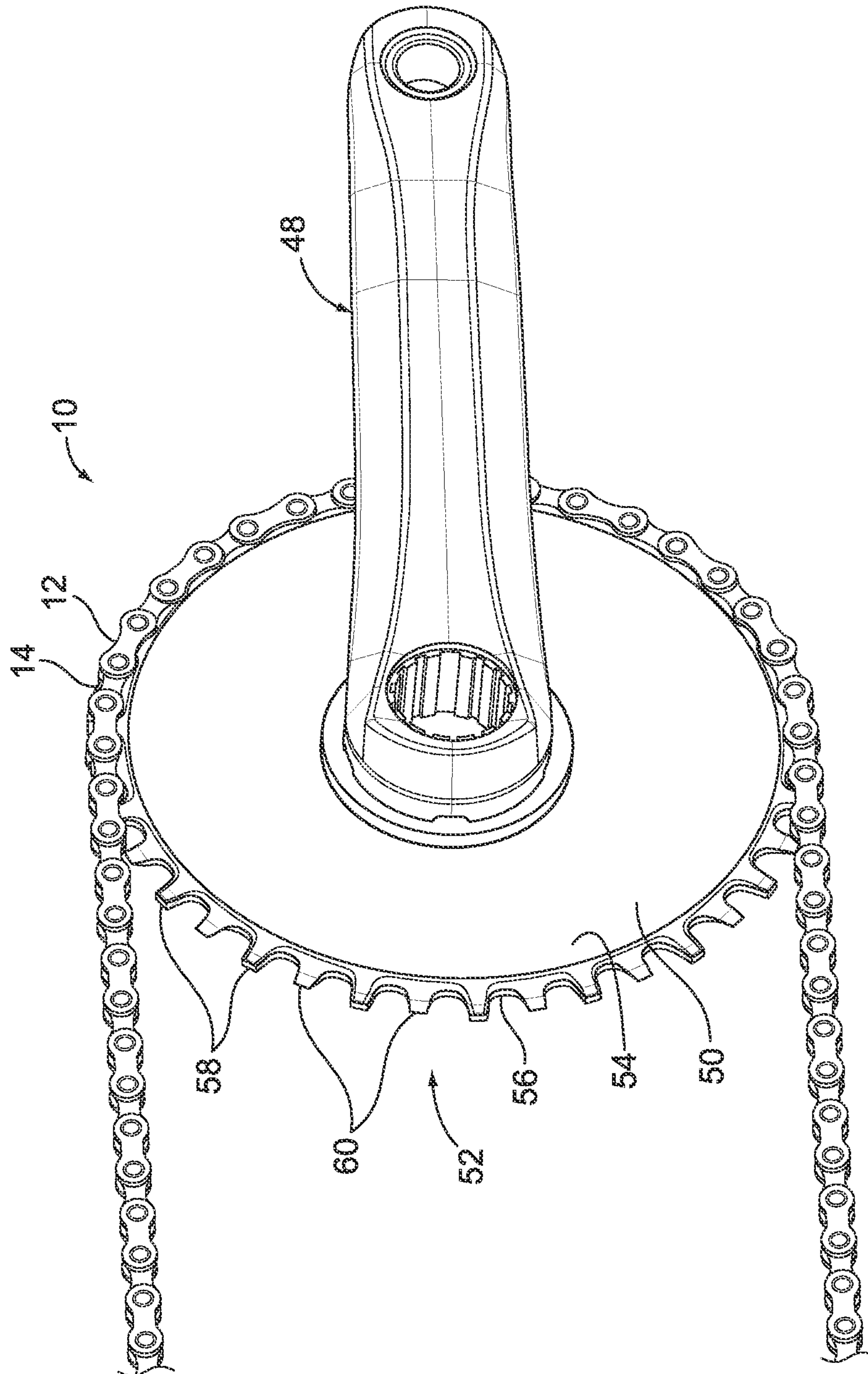


FIG. 3

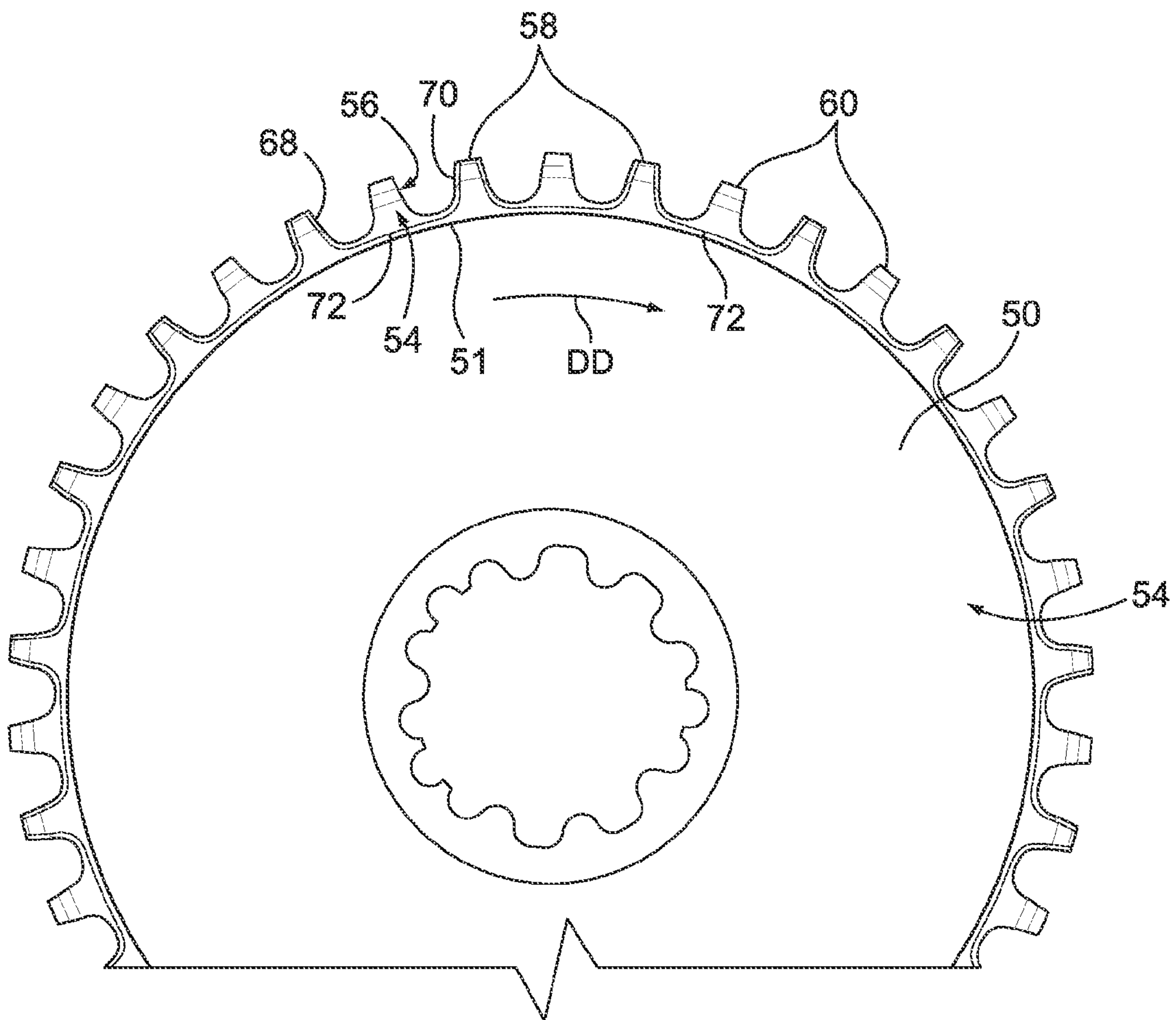


FIG. 4

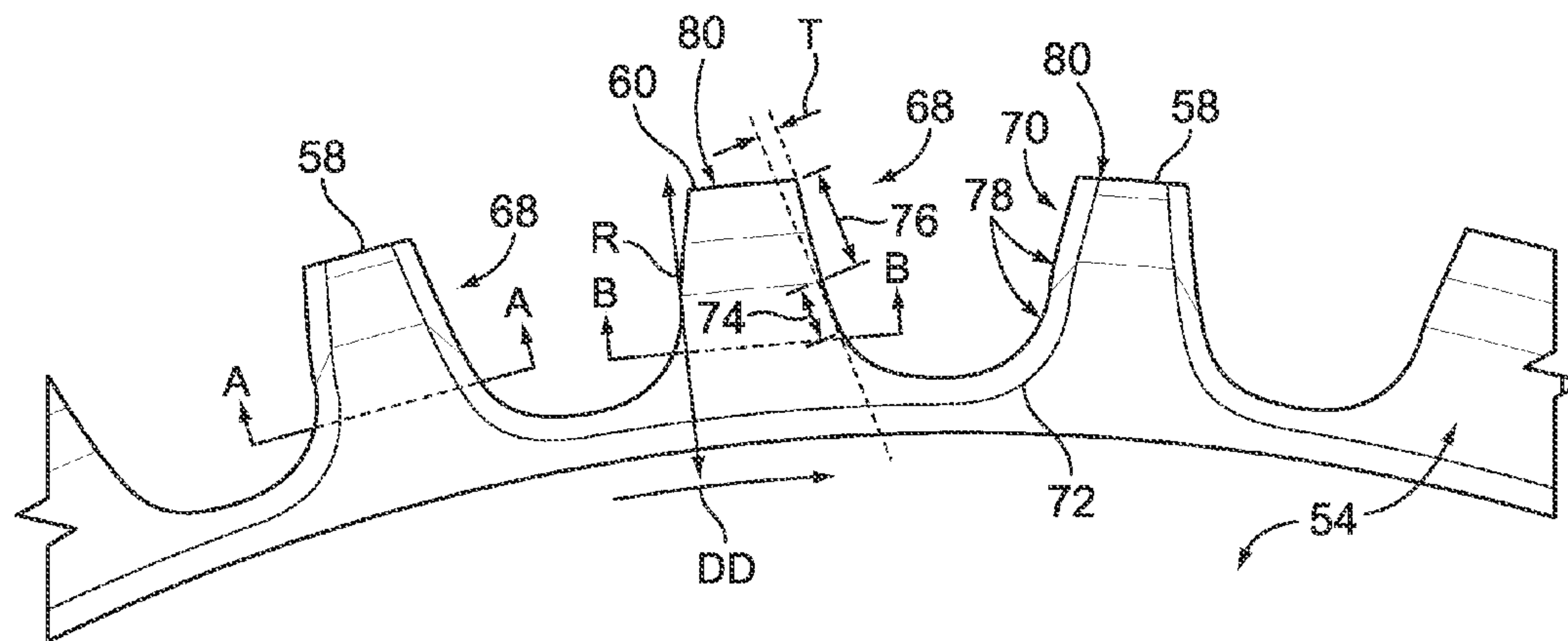


FIG. 5

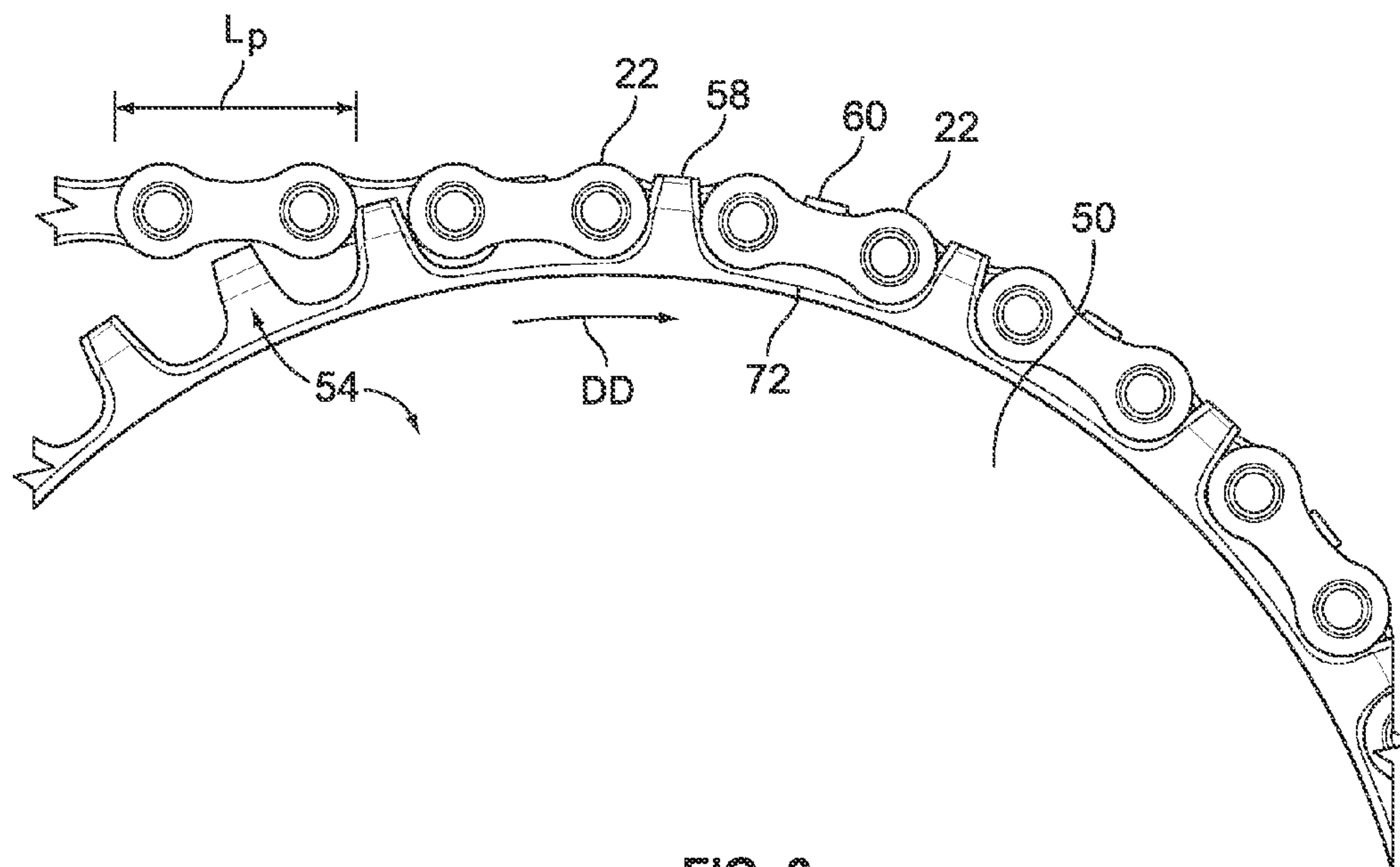
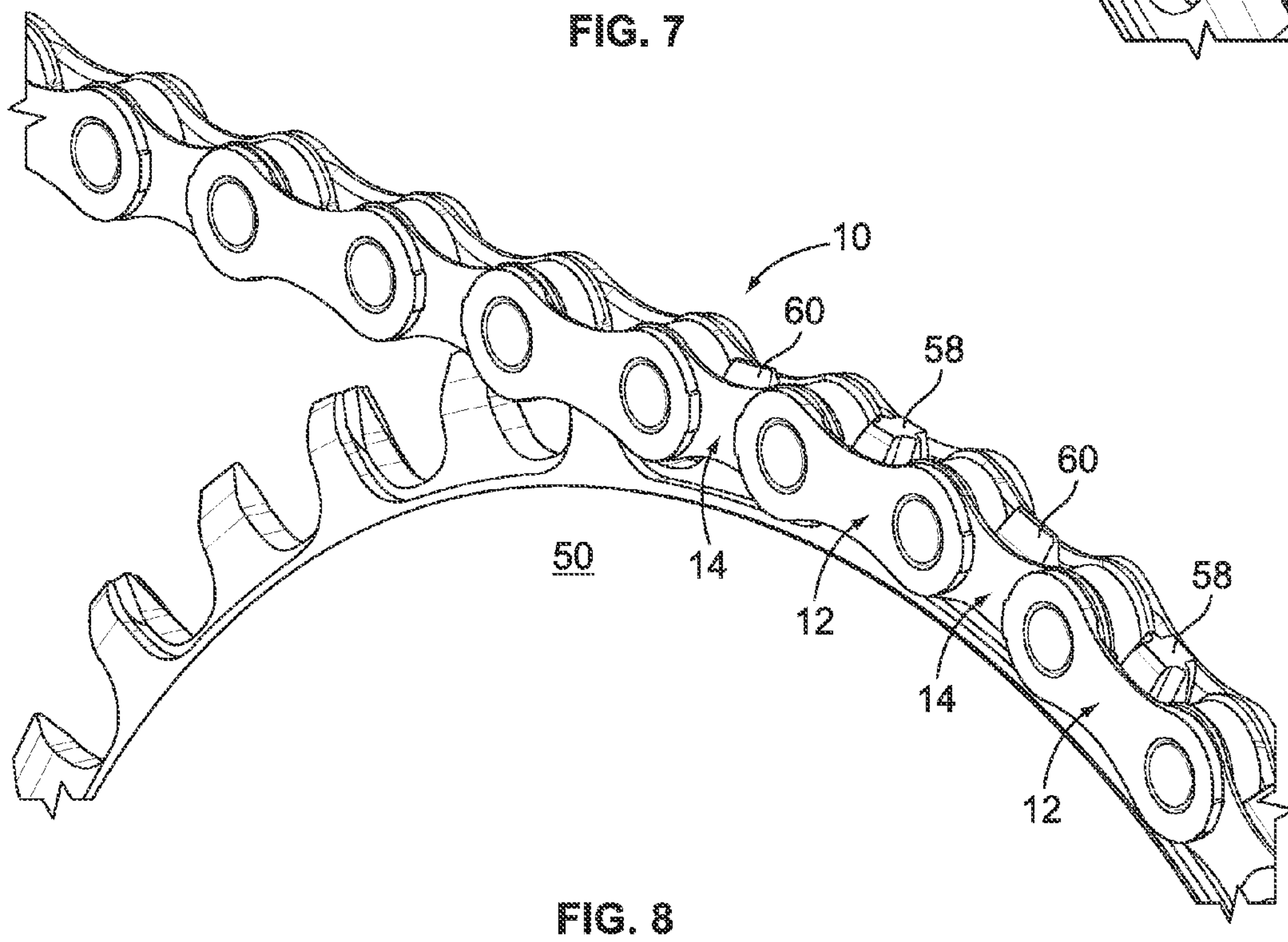
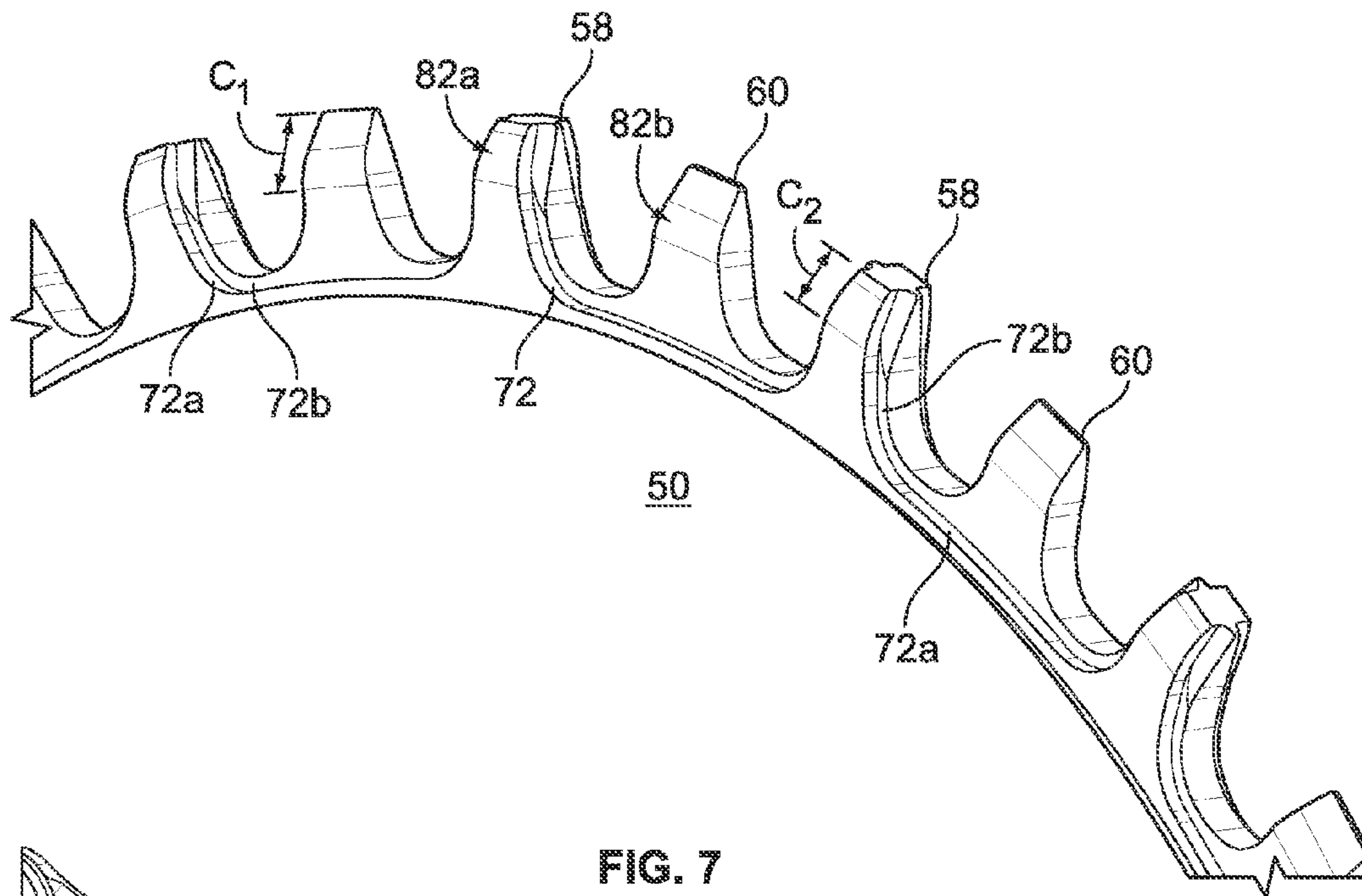


FIG. 6





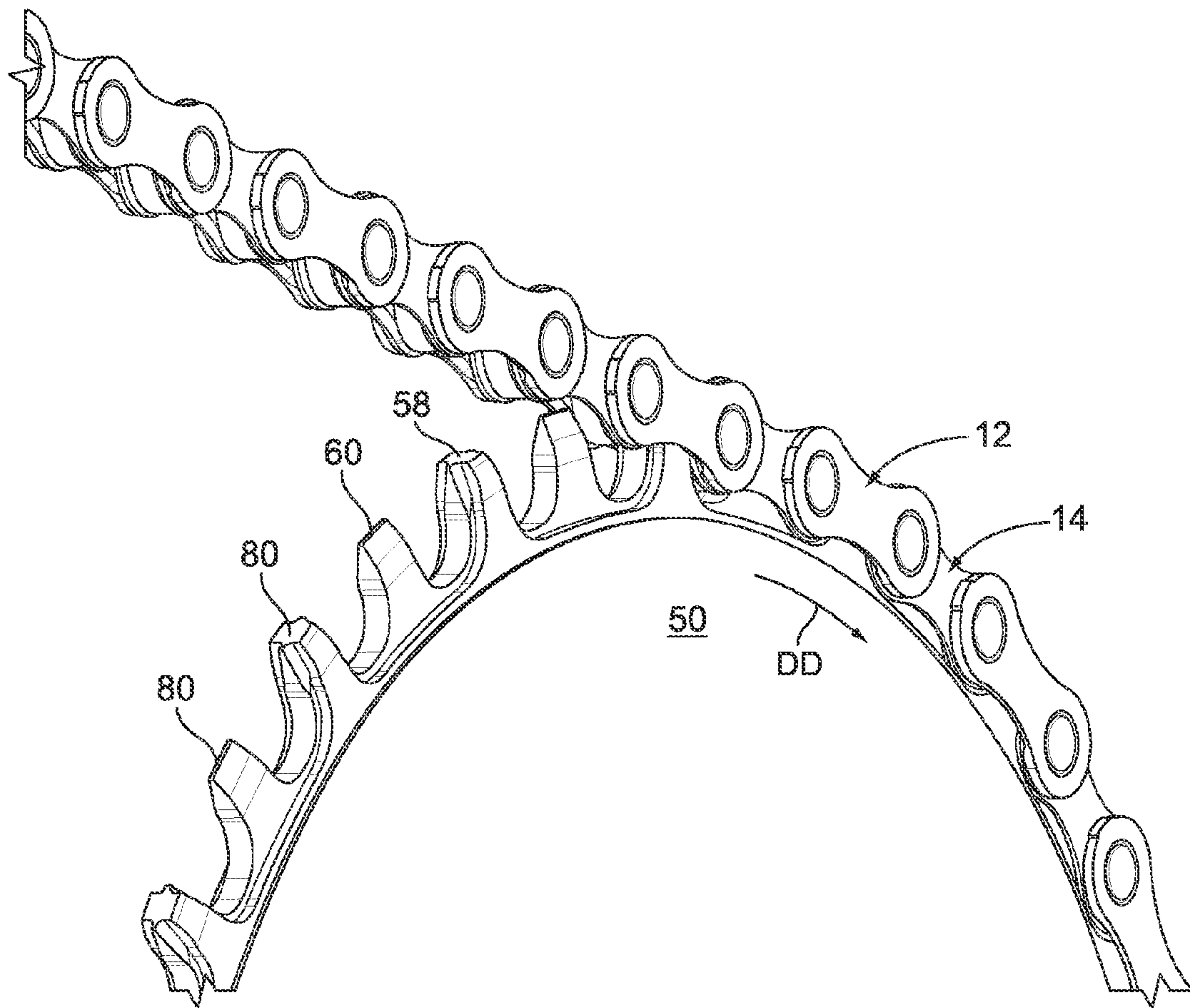


FIG. 9



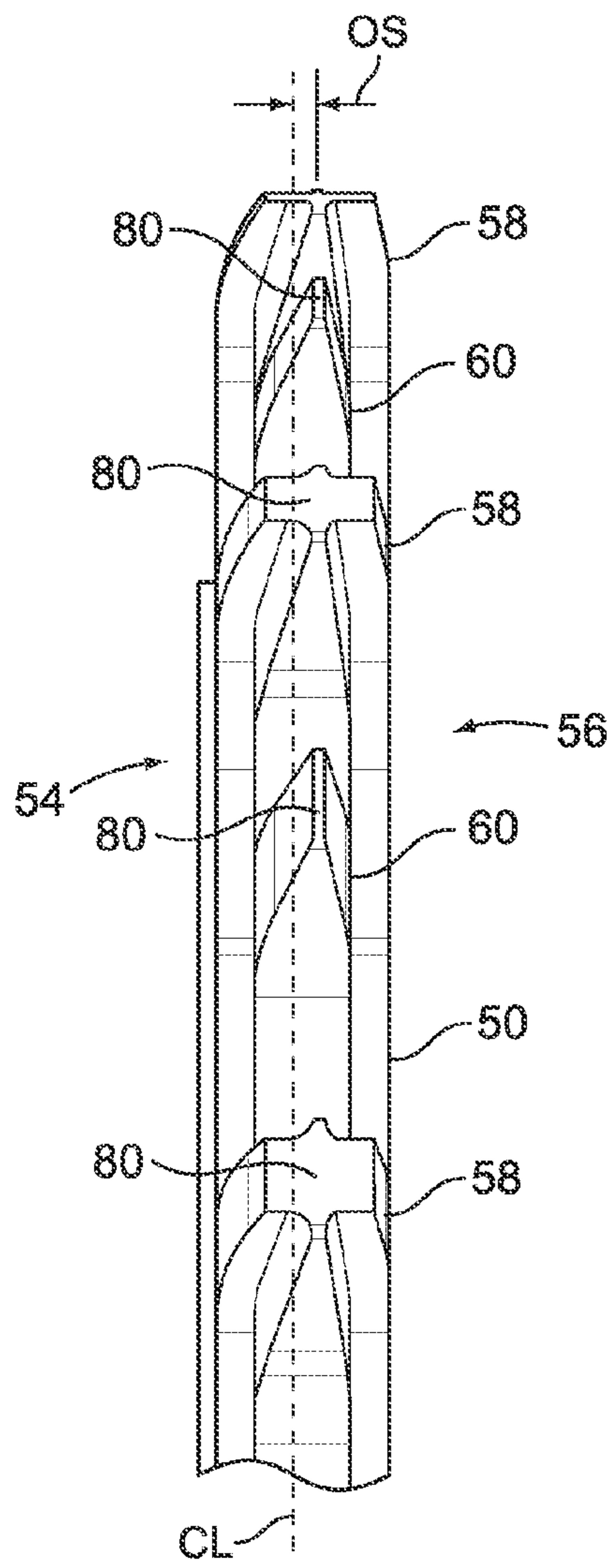


FIG. 10

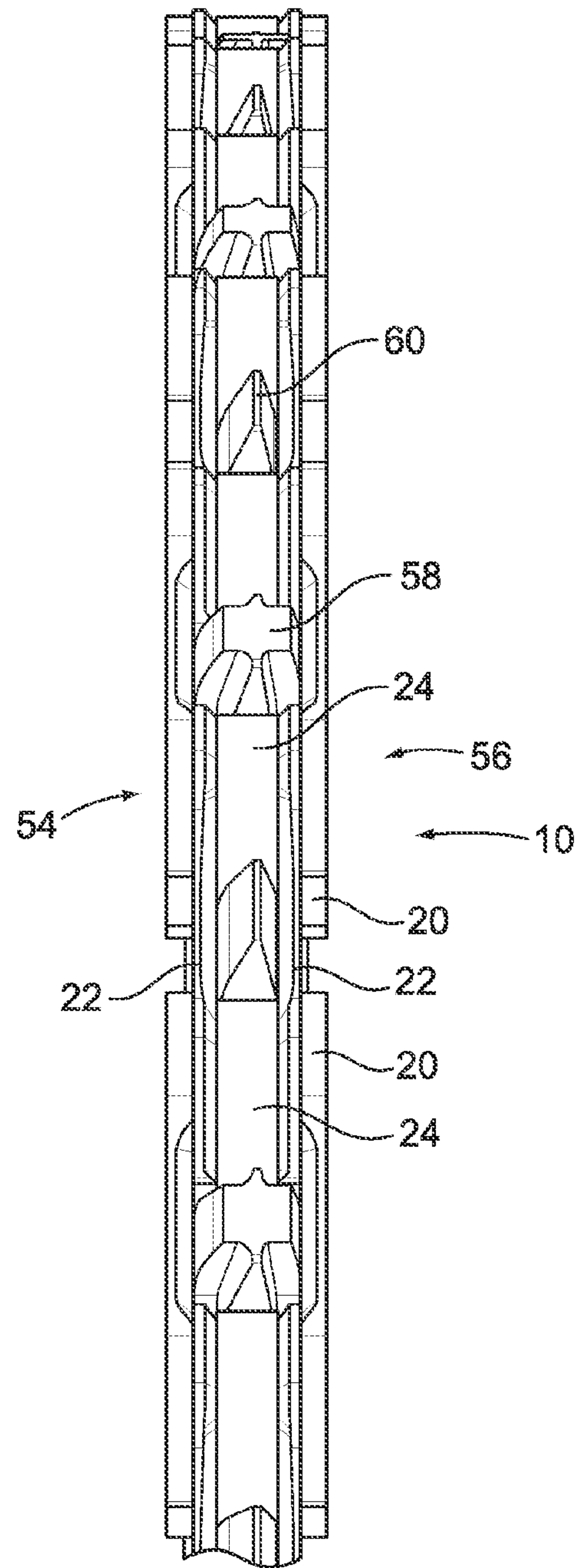


FIG. 11

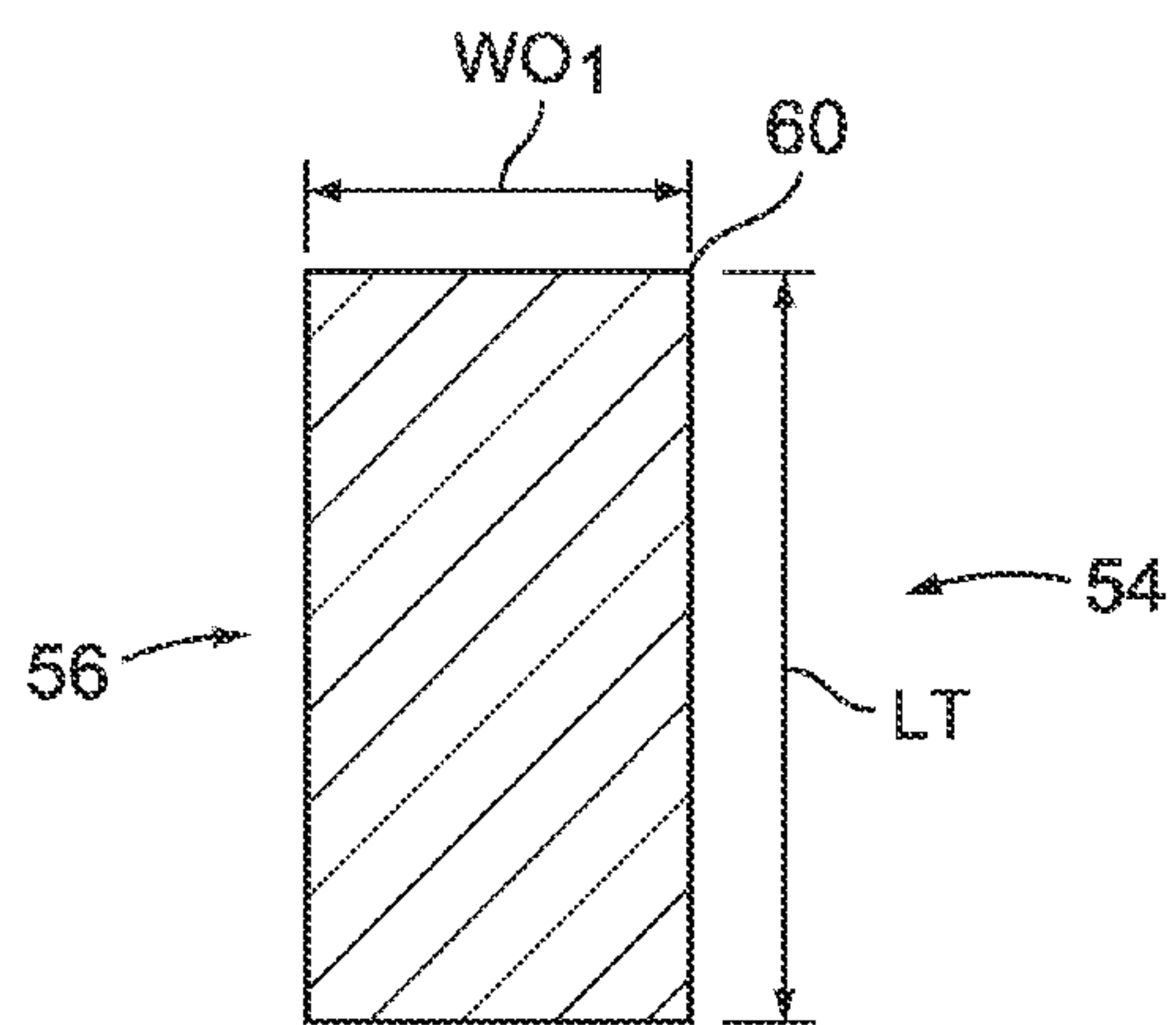


FIG. 12

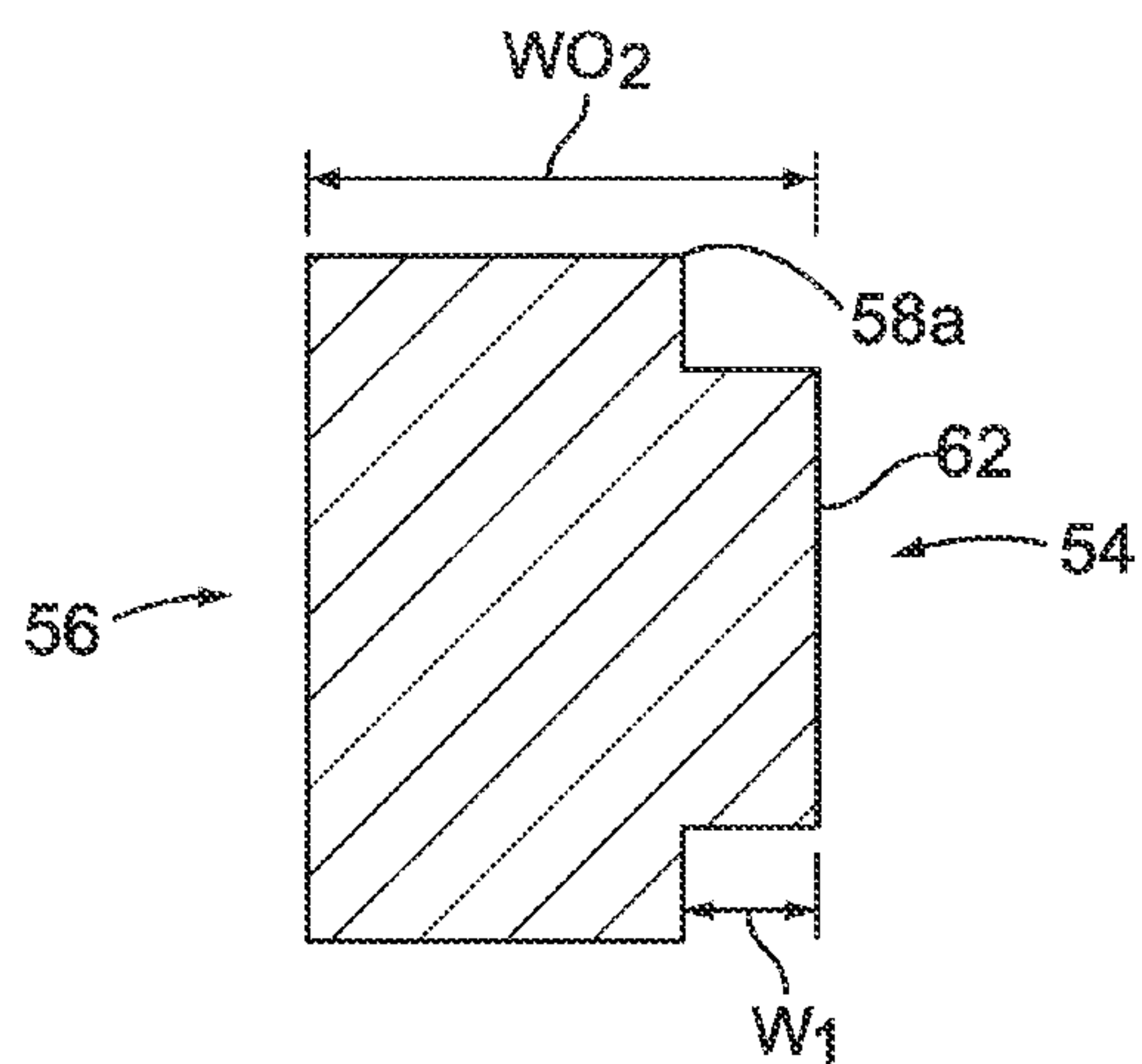


FIG. 13

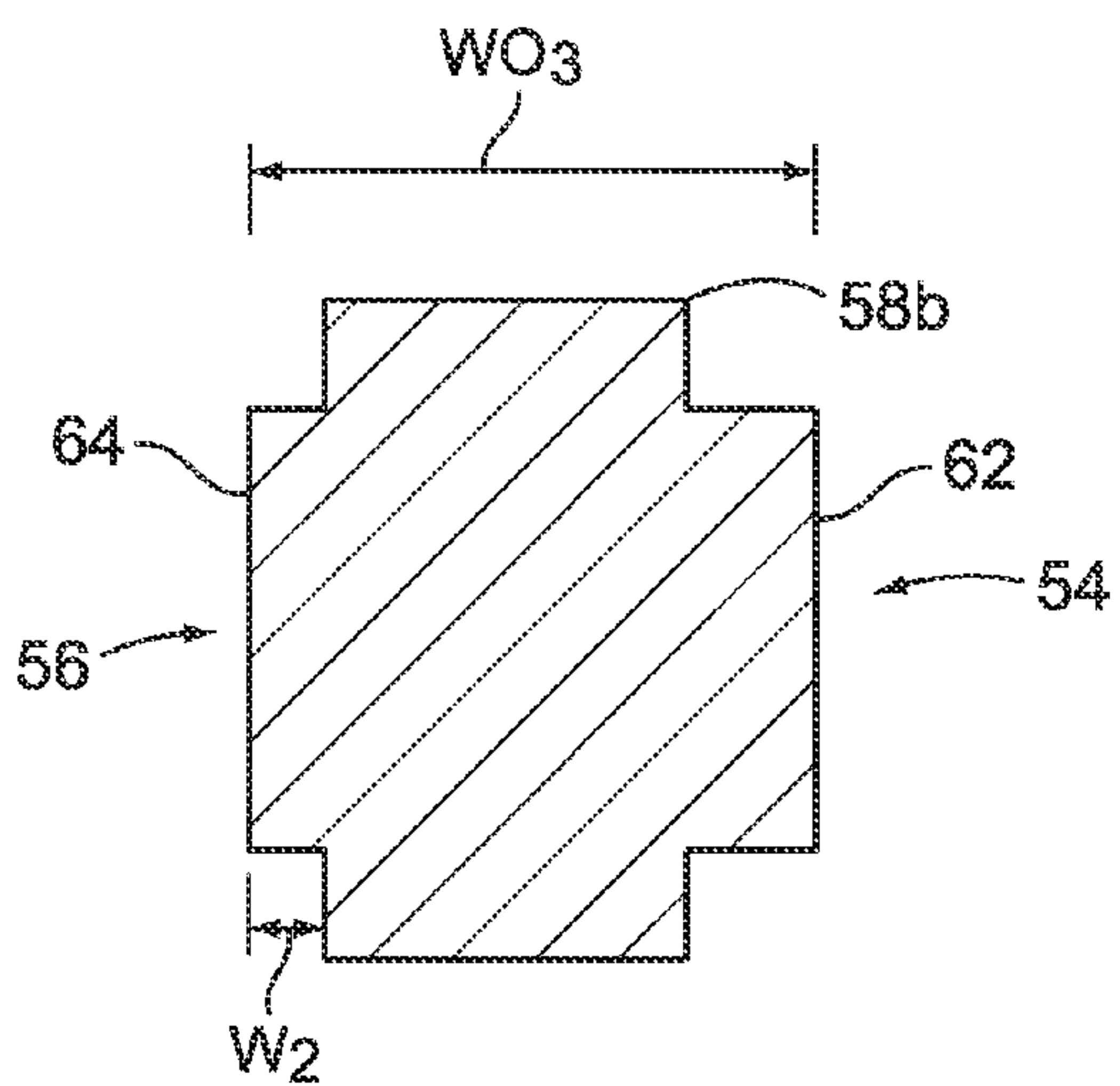


FIG. 14

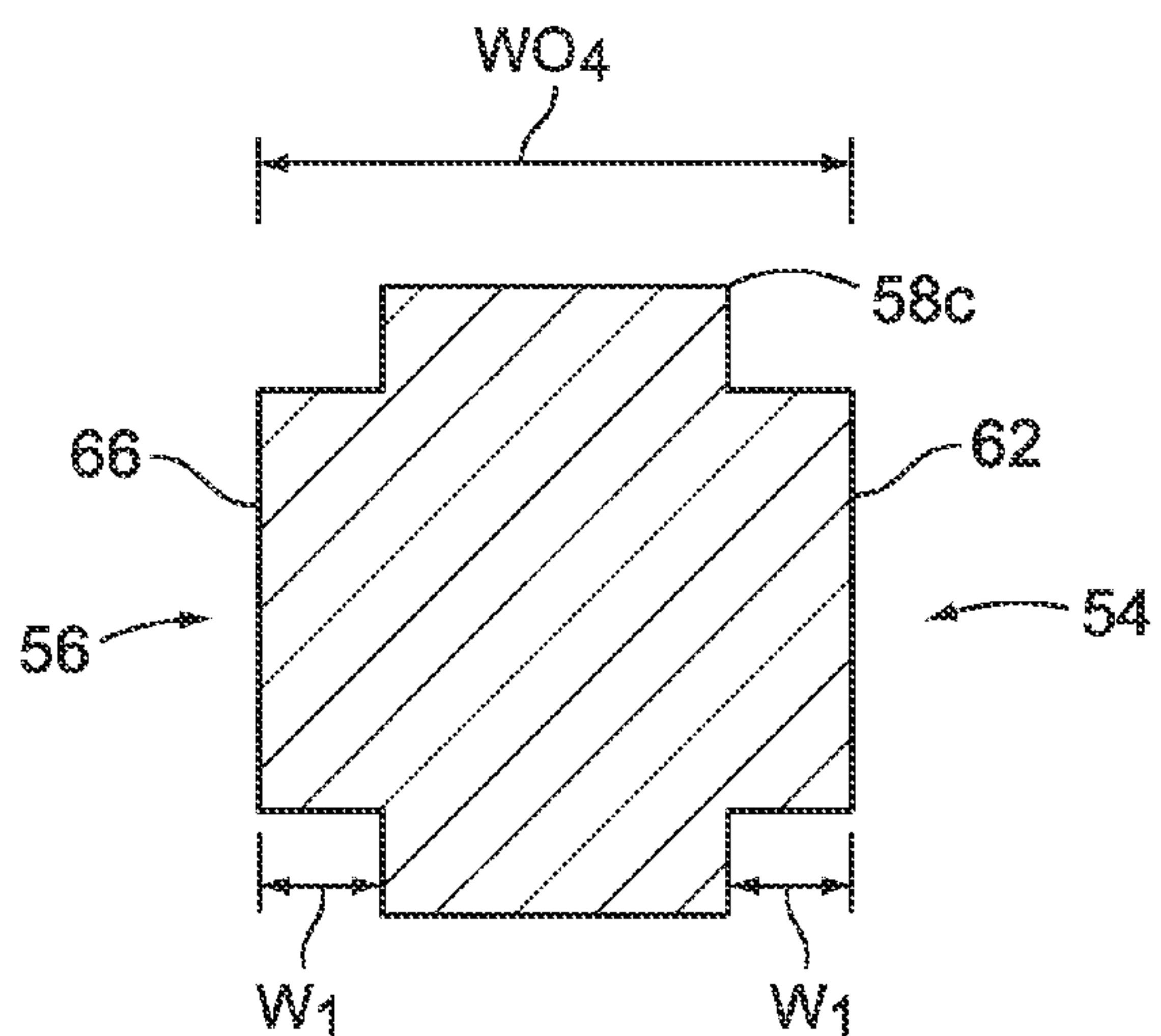


FIG. 15

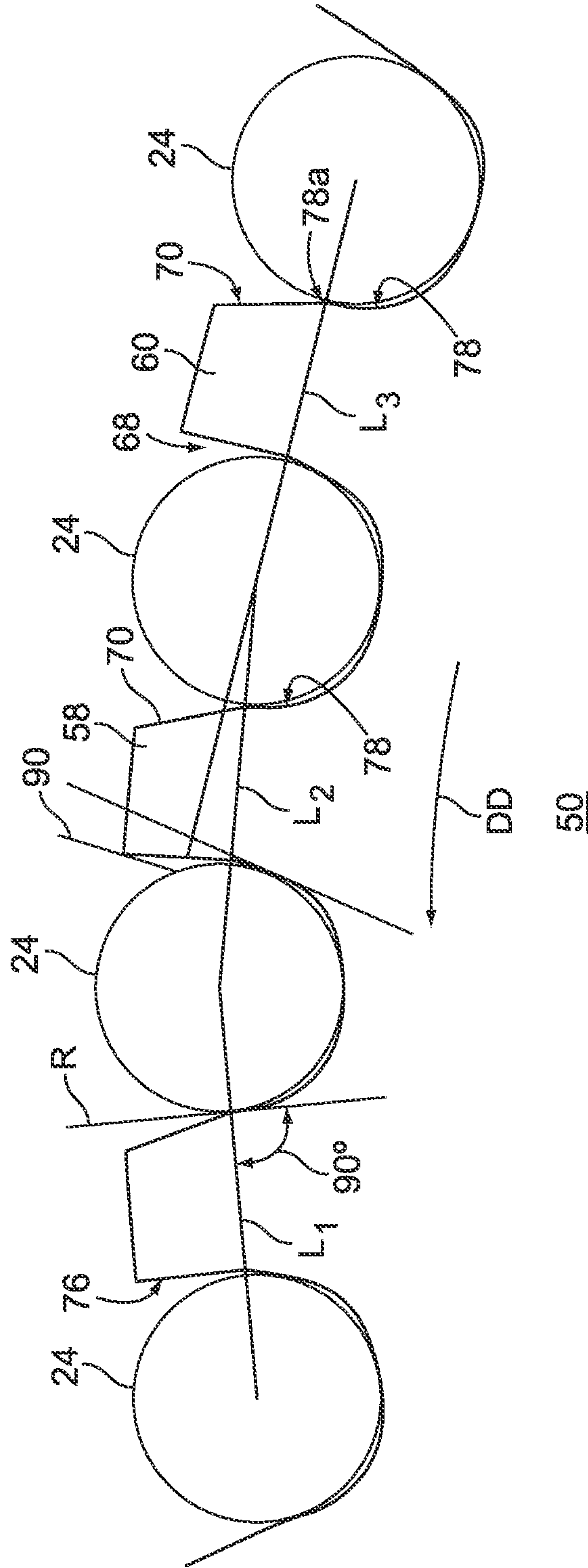


FIG. 16



# 1

## CHAINRING

This application is a continuation of U.S. patent application Ser. No. 13/311,735, filed Dec. 6, 2011.

### BACKGROUND OF THE INVENTION

This invention relates to chainrings, and more particularly, to a solitary chainring for use with a conventional chain in a bicycle drivetrain system including a bicycle crank.

Bicycles and other chain-driven vehicles typically employ one or more chainrings and a set of rear hub mounted sprockets connected by a chain. Various mechanisms are used to maintain the chain on the chainring and sprockets. These mechanisms include chain guards, chain tensioners, chain catchers, derailleur configurations and so on.

While riding a vehicle with a chain driven drivetrain, management of the chain and chainring engagement is particularly important to safe and effective propulsion of the bicycle. Keeping the chain engaged with the chainring can be difficult, which is especially true of geared bicycles which can experience severe changes in chain tension, and energetic motion of the chain, especially from riding over rough terrain.

Moreover, the chainring in any bicycle can potentially touch the chain stay of the bicycle frame when the crank is in a position where high loads are applied by the rider, causing an elastic deformation of the bicycle frame and the crankset. This can lead to damage to the frame and chainring and cause other problems.

The invention provides an enhanced drive chain management, especially for a bicycle that can successfully and reliably be ridden over rough and challenging terrain.

### SUMMARY OF THE INVENTION

The invention provides, in one aspect, a bicycle chainring of a bicycle crankset for engagement with a drive chain. The bicycle chainring includes a plurality of teeth extending from a periphery of the chainring wherein roots of the plurality of teeth are disposed adjacent the periphery of the chainring. The plurality of teeth including a first group of teeth and a second group of teeth, each of the first group of teeth wider than each of the second group of teeth. At least some of the second group of teeth are arranged alternately and adjacently between the first group of teeth, each of the plurality of teeth includes an outboard side and an inboard side opposite the outboard side and one of the inboard and outboard sides of each of the second group of teeth includes a link-receiving recess formed in the chainring, and wherein each link-receiving recess is defined by a circumferentially-extending base surface that extends continuously to a top land of each of the first group of teeth and by a radially-extending wall that extends to a top land of each of the second group of teeth.

These and other features and advantages of the present invention will be more fully understood from the following description of one or more embodiments of the invention, taken together with the accompanying drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a top view of a conventional drive chain;

FIG. 2 is a side view of the conventional drive chain of FIG. 1;

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FIG. 3 is an isometric view of a combined drive chain and chainring according to the invention engaged by a drivetrain;

FIG. 4 is a side view of the chainring according to the invention;

FIG. 5 is a close up of the chainring of FIG. 4;

FIG. 6 is a side view of a combined drive chain and chainring according to the invention engaged by a drive chain with the outer link plates removed;

FIG. 7 is a front isometric view of the chainring according to the invention;

FIG. 8 is a front isometric view of the chainring according to FIG. 7, engaged by a drive chain;

FIG. 9 is a rear isometric view of the chainring according to FIG. 7, engaged by a drive chain;

FIG. 10 is a front view of the chainring according to the invention;

FIG. 11 is a front view of the chainring according to the invention engaged by a drive chain;

FIG. 12 is a cross sectional view through line B-B of FIG. 5 of one type of gear tooth according to one group of teeth;

FIGS. 13-15 are cross sectional views through line A-A of FIG. 5 of alternative types of gear teeth that are different than the tooth of FIG. 12 and according to another group of teeth; and

FIG. 16 is a partial side view of the chainring according to the invention with rollers of a chain engaged with the teeth of the chainring.

### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the invention will herein be described with reference to the drawings. It will be understood that the drawings and descriptions set out herein are provided for illustration only and do not limit the invention as defined by the claims appended hereto and any and all their equivalents. For example, the terms "first" and "second" or "left" and "right" are used for the sake of clarity and not as terms of limitation.

Referring to FIGS. 1 and 2 of the drawings, numeral 10 generally indicates a conventional roller drive chain for a bicycle or any similar chain-driven device. The drive chain 10 generally includes outer chain links 12 and inner chain links 14 which are pivotally mounted on and connected to the outer chain links by pins 16, 18. The outer chain links 12 are alternately interleaved with the inner chain links 14.

The outer chain links 12 have paired outer link plates 20 and the inner chain links have paired inner link plates 22. Typically, rollers 24 are arranged around the pins 16, 18. The plates 20, 22 are provided with holes 30 at their ends 32. The pins 16, 18 typically extend through and project out of the holes 30, although no projection at all is considered to be optimal. The pins 16, 18 are externally riveted at their ends 34, 36 during the assembly of the roller chain 10. While the pin 16 may be made of round stock, pin 18 may be made of tube stock, as in the roller chain 10 in FIG. 2. A narrow middle part 38, which helps to determine the positioning of the roller chain 10 extends between the two circular ends 32 of each of the outer link plates 20 and the inner link plates 22.

As seen best in FIG. 1, and as viewed from above (or below) the chain, the interleaving of the outer links 12 and inner links 14 creates corresponding alternating outer link spaces 40 and inner link spaces 42. Generally, the outer link spaces 40 are openings defined by the outer link plates 20



and rollers **24**. Generally, the inner link spaces **42** are openings defined by the inner link plates **22** and rollers **24**.

The inner link spaces **42** are generally rectangular with the long axis of the rectangle aligned with the long axis (A) of the chain **10** (as viewed as in FIG. 1). The axial length of the inner link spaces **42** is determined by the distance between the rollers **24**, while the distance between the inner link plates **22** determines the transverse spacing of the inner link spaces.

As seen in FIG. 1, the outer link spaces **40** are generally in the shape of a “cross” or in other words, a “plus.” The axial length of the outer link spaces **40** is determined by the distance between the rollers **24**, while the distance between the outer link plates **20** determines the transverse spacing of the outer link spaces.

It can be seen that the transverse spacing between the outer link plates **20** is greater than the spacing between the inner link plates **22**. Thus, because the transverse width of the rollers **24** determines the spacing of the inner link plates **22**, the rollers dictate the transverse spacing  $D_1$  of the inner link spaces **42**. Similarly, since the outer link plates **20** are positioned on the pins **16** (or **18**) on the outboard sides of the inner link plates **22**, the transverse spacing  $D_2$  of the outer link spaces **40** is dictated by the sum of the transverse width of the rollers **24** and the thickness of two inner link plates.

Referring to FIG. 3, a chainring **50** according to the invention is used with a conventional chain **10**. Chainrings typically have a large plurality of teeth compared to cassettes, for example, having about **20** or more teeth. A crank or crank arm **48** is in a typical position and attached to the chain ring **50** in a well-known manner. The crank side of the chainring **50** is shown in FIG. 3, which is the outboard side **54** of the chainring. The outboard side also faces away from the vehicle to which it is attached. The opposite of the outboard side **54** of the chainring **50** is the inboard side **56**. The inboard side **56** faces toward the vehicle.

Generally, force applied to the crank arm **48** (typically in a downward direction, for example) causes rotation of the chainring **50** in a like direction (clockwise). Rotation of the chainring **50** causes the chain **10** to be drawn over and advanced about the chainring.

The chainring **50** has a plurality of teeth **52** formed about the periphery **51** of the chainring, with the total number of the plurality of teeth consisting of an even number. The plurality of teeth **52** include a first group of teeth **58** and a second group of teeth **60** arranged in an alternating fashion and wherein the first group of teeth is equal in number to the second group of teeth. In a most general form, the invention provides the first group of teeth **58**, that is configured to be received by and fitted into the outer link spaces **40**, and a second group of teeth **60** that is configured to be received by and fitted into the inner link spaces **42**.

The overall shape of the chainring periphery **51** may be generally circular or non-circular, that is elliptical, oval, polygon, or parabolic, for example. All of the examples of chainrings provided herein are shown with a circular periphery **51**.

Each of the first group of teeth **58** is configured to engage with the chain **10** via an outer link space **40**. Each of the second group of teeth **60** is configured to engage with the chain **10** via an inner link space **42**.

Turning to FIG. 12, each of the second group of teeth **60** has a shape which in a cross sectional view is generally rectangular, particularly at or near the base or root of the tooth. The cross sectional view is taken through a plane parallel to the top land **80** of the tooth and passing through

the base circle position of the tooth, i.e., about halfway between the root circle and the outside circle.

The rectangular cross section and overall width  $WO_1$  of each of the second group of teeth **60** should closely match the configuration of each of the inner link spaces **42** (FIG. 1). The cross section shown of each of the second group of teeth shows that the outboard side **54** is generally planar and the inboard side **56** is also generally planar. Each of the second group of teeth **60** may fill over about 75% of the axial distance  $D_1$  of a corresponding space in the chain **10**. Preferably, each of the second group of teeth **60** may fill over about 80% of  $D_1$  of a corresponding space in the chain **10**. More preferably, each of the second group of teeth **60** may fill over about 85% of  $D_1$  of a corresponding space in the chain **10**.

Turning to FIG. 13-15, each of the alternative versions of teeth **58a**, **58b**, **58c** of the first group of teeth **58** (see FIG. 3) has a shape which in a cross sectional view, taken through the tooth as in FIG. 12, has the same longitudinal length  $L_T$  as that of the second group of teeth **60** (FIG. 12). Each of the first group of teeth **58** may fill over about 75% of the distance  $D_2$  of a corresponding space in the chain **10**. Preferably, each of the first group of teeth **58** may fill over about 80% of  $D_2$  of a corresponding space in the chain **10**. More preferably, each of the first group of teeth **58** may fill over about 85% of  $D_2$  of a corresponding space in the chain **10**.

Each of the first group of teeth **58** has the additional feature of an outboard or first protrusion **62** on the outboard side **54** of each alternative teeth **58a**, **58b**, and **58c**. FIG. 13 also demonstrates that the inboard side **56** of tooth **58a** can be the same (i.e., without a protrusion) as the inboard side **56** of each of the second group of teeth **60**. The first protrusion **62** is configured to fit into the corresponding part of outer link spaces **40** of chain **10** (FIG. 1) and has a width  $W_1$ . The protrusion **62** functions to help maintain the chain **10** on the chainring **50** (FIG. 3). The protrusion **62** causes an overall width  $WO_2$  of each of teeth **58a** to be greater than the overall width  $WO_1$  of each of teeth **60** by the extent of protrusion **62**.

FIG. 14 is another embodiment of a tooth **58b** of the first group of teeth **58**. In particular, tooth **58b** is similar to those of FIG. 13, with the additional feature of an inboard or second protrusion **64** on the inboard side **56** of the tooth. The protrusion **64** has a width  $W_2$  that is less than the width  $W_1$  of the protrusion **62** of tooth **58a**, or alternatively, greater than  $W_1$ . The protrusions **62**, **64** cause an overall width  $WO_3$  of each of teeth **58b** to be greater than the overall width  $WO_1$  of each of teeth **60** by the extent of protrusions **62**, **64**. Furthermore,  $WO_3$  is greater than  $WO_2$ .

FIG. 15 is yet another embodiment of a tooth **58c** of the first group of teeth **58**. In particular, tooth **58c** is similar to that of FIG. 14, with an inboard or second protrusion **66** on the inboard side **56** of the tooth. The protrusion **66** has a width  $W_1$  that is equal to the width  $W_1$  of the protrusion **62** of tooth **58a**. The protrusions **62**, **66** cause an overall width  $WO_4$  of each of teeth **58c** to be greater than the overall width  $WO_1$  of each of teeth **60** by the extent of protrusions **62**, **66**. Furthermore,  $WO_4$  is greater than  $WO_3$ .

It will be understood that the various configurations of the teeth **58** include protrusions that are positioned along the side or sides of each tooth in a position where they effectively function to assist in positioning the chain on the chainring **50**, including positions that are adjacent or at the base of each tooth or higher on each tooth **58**.



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FIG. 4 and FIG. 6 is an outboard side 54 of chainring 50 and the driving direction DD. The first group of teeth 58 is alternatingly arranged with the second group of teeth 60.

The configuration of the second group of teeth 60 may be defined, with respect to the outboard and inboard sides 54, 56 of each of the teeth 60, by forming an inner link receiving recess 72 in the chainring 50 that represents material removed from the sides of the teeth 60. The inner link receiving recess 72 also serves to define the cross-sectional shape of each of the group of teeth 58. The inner link receiving recess 72 defines the outboard and inboard sides 54, 56 of each tooth and extends from the front flank 68 of one of the group of teeth 58 to a rear flank 70 of an adjacent one of the group of teeth 58 in the drive direction DD. Each inner link receiving recess 72 is configured to receive the length  $L_P$  an inner link plate 22 of the chain (FIG. 6). Each recess 72 has a base surface 72a that extends in an axial direction and a wall 72b (FIG. 7) that extends radially. The base surface 72a may describe a smoothly curving contour, and may be generally in the shape of a "U".

FIG. 5 is the profile of each tooth of the teeth 58, 60 in more detail. The inner link receiving recess 72 is formed in the chainring 50 and can be seen extending along the side of each of the second group tooth 60 and extending from the load side, front or leading flank 68 of one of the group of teeth 58 to a rear flank 70 of an adjacent one of the group of teeth 58 in the drive direction DD. The recess 72 is configured to receive the length  $L_P$  (FIG. 6) of an inner link plate 22. Each tooth may have a top land 80. The base surface 72a may extend to the top land 80 of each of the teeth 58. The front flank 68 of each tooth includes a contact zone 74, where a roller 24 (FIG. 1) contacts the tooth.

Above the contact zone 74 is an optional tip portion 76. The roller 24 does not contact the tip portion 76 under normal driving conditions. The tip portion 76 may protrude forwardly from a line drawn along the contact zone 74 a distance T. The protruding tip portion 76 functions to engage a chain link earlier than a chain lacking the tip portion and provides better guiding of the chain.

An optional hook feature 78 is a feature that may be formed on the rear flank 70 of each of teeth 58, 60. The hook feature 78 is positioned along the rear flank 70 and may cooperate with the tip portion 76 to provide better guiding of the chain. The hook feature 78 may include a portion of the rear flank 70 being aligned in the radial direction R.

Turning to FIG. 7 the first group of teeth 58 and the second group of teeth 60 of the chainring 50 are arranged in an alternating fashion. An optional feature of each of the first group of teeth 58 and second group of teeth 60 is a respective outer chamfer 82a, 82b. Each of the first group of teeth 58 has an outer chamfer 82a, which may be an arcuate face formed on the outboard side 54 or shoulder of each tooth. Each of the second group of teeth 60 has an outer chamfer 82b, which may be an arcuate face formed on the outboard side 54 or shoulder of each tooth. The outer chamfer of 82b of each tooth 60 may have an extent  $C_1$  that is greater relative to the extent  $C_2$  of the outer chamfer 82a of each tooth 58.

Turning to FIGS. 8 and 9 the chainring 50 includes chain 10 positioned and engaged thereon. Outer chain links 12 are positioned on the first group of teeth 58. Inner chain links 14 are positioned on the second group of teeth 60.

FIGS. 10 and 11 respectively is a front view of the chainring 50 without a chain 10 and with a chain. An optional feature of all of the teeth 58, 60 of the chainring 50 is an offset OS of the center of the tooth tip or top land 80 from the center line CL in a direction toward the inboard side

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56 of the chainring. This offset feature provides better guiding of the chain to one side of the chainring.

Turning to FIG. 16, a chainring 50 includes a number of teeth 58, 60. Link 1 of a chain engaged on the chainring 50 is represented by line  $L_1$ , and link 2 and link 3 are represented by lines  $L_2$ ,  $L_3$  respectively. The line of each of  $L_{1-3}$  is drawn between the centers of the axis of each of the chain rollers 24.

The hook feature 78 is shown on the rear flank 70 of each of teeth 58, 60. The hook feature 78 is positioned along the rear flank 70 and may cooperate with the tip portion 76 of the front flank 68 to provide better guiding of the chain. The hook feature 78 may include a portion of the rear flank 70 being aligned in the radial direction R. The hook feature 78 has a radially outermost extent 78a where the hook feature and the link centerlines  $L_{1-3}$  intersect. Alternately, the outermost extent 78a may be higher than the centerlines  $L_{1-3}$  providing more room for the roller to engage the teeth in the driving direction. The curved line 90 is the path of the roller 24 when it disengages the tooth.

In use, the chain 10 is installed with each of the outer chain links 12 on one of the first group of teeth 58 and each of the inner chain links 14 on one of the second group of teeth 60. As the chainring 50 is rotated by the crank 48, the chain 10 is drawn about the chainring, and the outer chain links 12 and the inner chain links 14 are sequentially engaged with respective first and second ones of the groups of teeth 58, 60. As detailed above, the various features of the chainring 50 function to guide and maintain the chain 10 thereon.

While this invention has been described by reference to particular embodiments, it should be understood that numerous changes could be made within the spirit and scope of the inventive concepts described. Accordingly, it is intended that the invention not be limited to the disclosed embodiments, but that it have the full scope permitted by the language of the following claims.

The invention claimed is:

1. A bicycle chainring of a bicycle crankset for engagement with a roller drive chain having alternating outer and inner chain links defining outer and inner link spaces, comprising:

a plurality of teeth extending from a periphery of the chainring wherein roots of the plurality of teeth are disposed adjacent the periphery of the chainring;

the plurality of teeth including a first group of teeth and a second group of teeth, each of the first group of teeth sized and shaped to fit within the outer link spaces, and each of the second group of teeth sized and shaped to fit within one of the inner link spaces, each of the first group of teeth wider than each of the second group of teeth, wherein the first group of teeth has a cross-shaped cross section adjacent a top land thereof and adjacent a base thereof;

at least some of the second group of teeth arranged alternatingly and adjacently between the first group of teeth;

wherein each of the plurality of teeth includes an outboard side and an inboard side opposite the outboard side and one of the inboard and outboard sides of each of the second group of teeth includes a link-receiving recess formed in the chainring; and

wherein each link-receiving recess is defined by a circumferentially-extending base surface that extends continuously to a top land of each of the first group of teeth and by a radially-extending wall that extends to a top land of each of the second group of teeth.



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2. The bicycle chainring of claim 1, wherein each of the plurality of teeth includes an outboard side and an inboard side opposite the outboard side and each of the first group of teeth includes at least a first protrusion on one of the outboard side and the inboard side and each of the second group of teeth are free of the first protrusion. 5

3. The bicycle chainring of claim 2, wherein each of the first group of teeth includes at least a second protrusion on the other of the outboard and inboard sides.

4. The bicycle chainring of claim 3, wherein the first protrusion has a first width and the second protrusion has a second width; and 10

wherein the first and second protrusion widths are one of equal and unequal.

5. The bicycle chainring of claim 1, wherein the first group of teeth is wider than the inner link spaces. 15

6. The bicycle chainring of claim 1, wherein the second group of teeth having a rectangular-shaped cross-section adjacent a top land thereof and adjacent a base thereof.

7. The bicycle chainring of claim 1, wherein the plurality of teeth consists of an even number; and 20

wherein each of the first group of teeth are arranged alternately between the second group of teeth.

8. A bicycle crankset including the bicycle chainring of claim 1, the bicycle crankset further comprising: 25  
a crank arm including only the single bicycle chainring attached to the crank arm.

9. A bicycle drivetrain including the bicycle chainring of claim 1, the bicycle drivetrain further comprising: 30

a plurality of rear hub mounted sprockets; and

a roller drive chain connecting one of the plurality of sprockets to the chainring, the drive chain including alternating outer and inner chain links defining outer and inner link spaces, respectively.

10. The bicycle drivetrain of claim 9, further comprising: 35  
a crank arm including only the single bicycle chainring attached to the crank arm.

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11. A bicycle drivetrain, comprising:

a bicycle chainring for engagement with a roller drive chain, comprising:

a plurality of teeth extending from a periphery of the chainring wherein roots of the plurality of teeth are disposed adjacent the periphery of the chainring, the plurality of teeth including a first group of teeth and a second group of teeth, at least some of the second group of teeth arranged alternately and adjacently between the first group of teeth;

wherein the second group of teeth include a link-receiving recess formed in the chainring, the link-receiving recess defined by a circumferentially-extending base surface that extends continuously to a top land of the first group of teeth and by a radially-extending wall that extends to a top land of each of the second group of teeth;

a plurality of rear hub mounted sprockets; and

a roller drive chain connecting one of the plurality of sprockets to the chainring, the drive chain including alternating outer and inner chain links defining outer and inner link spaces, respectively, wherein the first group of teeth are configured to fit within the outer link spaces.

12. The bicycle drivetrain of claim 11, wherein the plurality of teeth consists of an even number; and wherein each of the first group of teeth are arranged alternately between the second group of teeth.

13. The bicycle drivetrain of claim 12, wherein the first group of teeth is equal in number to the second group of teeth.

14. The bicycle drivetrain of claim 11, wherein the first group of teeth include at least a first protrusion configured to fit into a corresponding part of the outer link spaces.

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